Presidential Address

Lewis and Clark, pioneers, and the American dream

Donald B. Doty, MD

It is my honor and pleasure to provide this address as the twenty-sixth president of The Western Thoracic Surgical Association. According to tradition, it is my responsibility as president to address the "weighty" matters of our specialty of thoracic surgery. There are certainly enough problems facing us that I could choose from many subjects on which to speak. It is widely known that there is declining reimbursement for our services. We may no longer be attracting the best and brightest young physicians to our specialty, and residency training positions are going unfilled. Plaintiff's attorneys are constantly looking over our shoulders, and law suit for medical malpractice is a threat every time we operate. The cost of liability insurance to protect ourselves increased an average of 44% this year, reaching preposterous rates because of inflated negligence settlements. Government agencies and their "third-party" insurers are regulating and administering our affairs and squeezing us unmercifully. The Federal Bureau of Investigation could enter our offices at any time and investigate us for fraud, with the threat of stiff fine or even incarceration. There is a crisis in research. The cardiologists are taking our business, touting claims of zero restenosis with chemically coated intracoronary stents. Our patients are older and have higher acuity of illness, obesity is rampant, they all bleed more, and operations take longer. Are these enough reasons for doom and gloom and dissatisfaction with our occupation?

Let me remind you, however, that we have the absolute best occupation. Is there anything that you would rather do than thoracic surgery? Would you rather be a commercial airline pilot, subject to endless paperwork and regulations and your income depending on union contracts for the few minutes of exciting work getting an airplane off and back onto the ground? Perhaps you would like to spend your day sitting in front of a computer, analyzing spreadsheets or market trends for some money business on Wall Street. Factory workers receive the same income as cardiac surgeons in China, but would you rather be a factory worker?

Well, I am going light on doom and gloom. I determined a long time ago that if I were ever given the opportunity to address a professional society as president, I would avoid doom and gloom in favor of encouragement and, I hope, inspiration. I wish that I were bright enough to give you the answers to the universe in a nutshell, but you will have to let Stephen Hawking[1] do that for you. My objective is to provide some comfort for a very uncomfortable period in the evolution of our specialty.

The title that I have chosen for my talk is "Lewis and Clark, Pioneers, and the American Dream." It could be subtitled: "Explorers and Pioneers."

Thomas Jefferson became president of the United States in 1801. Jefferson was threatened by the strong possibility of the British establishing a solid land claim to the disputed Oregon Country, which included today's British Columbia, Washington, Oregon, and parts of Idaho and Montana. A solid British claim to Oregon would prevent the United States from becoming the nation that Jefferson dreamed of

From the Department of Surgery, LDS Hospital, Salt Lake City, Utah.

Read at the Twenty-eighth Annual Meeting of The Western Thoracic Surgical Association, Big Sky, Mont, June 19-22, 2002.

Received for publication June 24, 2002; accepted for publication July 1, 2002.

Address for reprints: Donald B. Doty, MD, 324 Tenth Ave, Salt Lake City, UT 84103 (E-mail: LDDOTY@IHC.com).

J Thorac Cardiovasc Surg 2003;125:3-11

0022-5223/2003 $30.00+0

doi:10.1067/mtc.2003.58

spanning the continent from coast to coast. Great Britain, Spain, Russia, and the United States had sailed short distances into the Columbia River estuary and by "discovery" had laid claim to the entire river drainage, completely ignoring the occupancy of the land by generations of indigenous people. Jefferson reasoned that the American claim to the land would be strengthened by being the first to cross the continent by land into the Columbia River drainage. The way across the land was at the time unknown, and there were no dependable maps of the land west of what is now North Dakota. Jefferson and Meriweather Lewis, his personal secretary, began planning an expedition[2] and received Congressional approval. Jefferson's charge to Lewis was to find the most direct and practical route across the Oregon territory to the west coast and to map the region. Further, Lewis was to study the region and describe in detail the plants, animals, minerals, and soils. He was to establish diplomatic relations with the Indian nations that inhabited the area and to engage them in trade, especially the lucrative fur trade. By 1803, Lewis was on his way west. In the meantime, France had sold the Louisiana territory, a vast tract of land occupying the middle portion of the continent, to the United States. In Pittsburgh, Lewis waited for the construction of the expedition's keel boat and recruited a crew of 11 men. In Clarksville, Indiana, he picked up his friend and former army commander, William Clark. They navigated down the Ohio River to the great Mississippi and then north to St Louis, where they halted for the winter. On May 14, 1804, they set off in the large keel boat and two smaller open boats on a 4000-mile voyage to the west coast, a trip that required 18 months of travel. They were the corps of discovery, two captains, aged 29 and 33 years, 45 men, a couple of horses, and a dog. Twenty-five men made up the permanent party that would make the entire journey to the Pacific and back; the others would remain behind with the boats when the rivers were no longer navigable. They ascended the Missouri River to the Mandan villages near present-day Bismark, North Dakota, arriving in the fall and spending the winter there. Here they added Toussaint Charbonneau as an interpreter and cook, along with his wife Sacagawea, a 15-year-old Shoshone woman who was 6 months' pregnant. She had been abducted, sold as a slave, and again sold as a wife to Charbonneau. Her ability as a guide and interpreter would later be not merely valuable but essential. Lewis, a competent practical doctor, delivered her baby, Jean Baptiste, later named Pompy. They continued their journey west on the Missouri River on April 7, 1805. It was in June that the corps reached the Great Falls of the Missouri. An 18-mile portage around the falls commenced nearly 200 years ago, on June 21. The corps reached Three Forks, located near Bozeman, Montana, on July 27. It was a summer campground for the Shoshones and the place from which Sacagawea had been abducted 4 years previously. She recognized the area and knew that her people were near. Lewis and Clark named the three rivers the Jefferson, in honor of President Thomas Jefferson, the Madison, in honor of James Madison, the secretary of state, and the Gallatin, in honor of Albert Gallatin, the secretary of treasury. They trekked a full day up each of the three branches of the river before deciding correctly to follow the Jefferson River. You know the rest of the story. Sacagawea determined the success of the expedition by securing horses, which were needed to cross the mountains leading to the Columbia River, from the Shoshones. They followed the Jefferson River drainage on foot and horseback after it was no longer navigable by boat. They crossed the Continental Divide at Limhi Pass, observing an eastward-flowing spring, the headwater of the great Missouri River. They nearly froze and starved to death in the mountains at Lolo Pass. They did make it to the Pacific Ocean at the mouth of the Columbia River, where they spent the rest of the winter. They returned triumphantly, arriving in St Louis on September 23, 1806.

What was accomplished by this expedition? They traveled 8000 miles, charted the length of the Missouri and much of the Columbia rivers, established good relations with many Native American nations, and added 178 plants and 122 animals to our knowledge by their detailed journals. They claimed to have discovered a practical and navigable passage across the continent of North America, but no wagon would ever follow their footsteps. The terrain was much too difficult for wagon travel.

Adventurous entrepreneurs began to enter the West. These men, known as "mountain men," were solitary fur trappers living completely off the land and roaming hundreds or even thousands of miles through the area each year. Jim Coulter in 1808 stumbled onto the geothermal activity of what is now Yellowstone National Park. No one believed his tales of what he saw there. Jim Bridger sailed down the Bear River in Utah into what he thought was the Pacific Ocean, but it was actually the Great Salt Lake. The lure of the beaver pelt for fur trading set up the second major westward expedition, funded by John Jacob Astor. The overland party tried to get through the Snake River, a route abandoned by Lewis and Clark. The expedition was in deep trouble, and a few men led by Robert Stuart returned to St Louis for help. On the way east in 1813, Stuart discovered South Pass, a passage where wagons could get through. Astor considered knowledge of South Pass to be proprietary information and suppressed word of its existence for many years. Jedediah Smith, perhaps the greatest mountain man of all, rediscovered South Pass in 1825 and made sure that everyone knew about this important corridor, thereby opening the West to emigration by overland wagon travel. South Pass is a 20-mile wide gap in the Rocky Mountains through which virtually the entire westward emigration passed. The

maps that Jedediah Smith made of his travels, along with those made by John C. Fremont in 1842, became the only accurate and comprehensive guides to the American West for decades. Fremont did much to stimulate the emigration to the West through published reports of his journeys. These reports made the trip west seem easy and enjoyable and did much to stir up excitement for westward travel. The reports were actually written by his wife Jesse Benton Fremont.

What did these men of discovery leave behind? Almost nothing. They were explorers, adventurers, entrepreneurs, not settlers. They were "ones who travel for purposes of discovery in regions previously unknown or little known."[3] They were a different lot from those defined as pioneers: "ones who go before into that which is unknown or untried, to prepare the way for others, as an early settler or a scientist doing original work" (*Webster's New Twentieth Century Dictionary* definition,[3] Table 1). It was the pioneers who ventured west to occupy, settle, and lay claim to all the lands of the West, the "manifest destiny" of the United States of America. It was the efforts of the pioneers that resulted in the population, growth, and permanent development of the West. All of us who live in the West owe a debt of gratitude to them.

William Sublette took wagons along the Platte River to the Rocky Mountains in 1830. Benjamin Bonneville took wagons across South Pass to the Green River in 1831. John Bidwell led the first genuine emigrant train to Oregon in 1841. John C. Fremont guided emigrants to Oregon in 1843, the "Year of the Great Migration." Brigham Young entered the Great Salt Lake valley in 1847 to create a permanent settlement, which would grow rapidly over the succeeding years.

Brigham Young was conscious of the continuing lack of security for his people in Nauvoo, Illinois. Simply speaking, they weren't getting along very well with their neighbors. He began investigating sites in the West as a haven of refuge for his people. In 1845 it was announced that the Mormons would leave Nauvoo for the West in 1846.

And so on February 7, 1846, they began crossing the Mississippi River into the cold blast of the Illinois-Iowa winter. They camped for 3 weeks at Sugar Creek, 8 miles west of Nauvoo. Bitter cold, snow, and wind are the rule for February in Iowa. Iowa is a rich land, heavily wooded, with impassable brush, all from nourishment of fertile soil by frequent rain storms. There were about 3000 people and nearly 500 wagons that began working their way west on March 1. In Iowa they encountered mud, boot-sucking mud. They were hampered by knee-deep mud and drenching rain. At times the horses would sink to their bellies. Travel was difficult and dangerous. It was slow going. It took 108 days to reach the Missouri River at Council Bluffs on June 16, 1846. They established camps on the east side of the Missouri River.

In early April 1847, the vanguard company of pioneers led by Brigham Young was ready to travel further west. The company consisted of 143 strong men, 3 women, 2 children, and numerous livestock. There were 72 wagons. They would travel on the established Oregon trail route along the North Platte river to the Sweetwater River to the west. William Sublette had led the first wagon train over this trail 17 years previously, in 1830. They would pass the most famous landmark in Nebraska, Chimney Rock. This marked the half-way point to the Great Basin. The rutted road led them past Scott's Bluff. There were some way stations established along the route for trading, but nothing that could supply a large body of emigrants. Fort Laramie, founded in 1834, was the first permanent human habitation west of the Missouri River. It was 397 miles to the next important outpost, Fort Bridger. Entering the prairie of Wyoming, there was little vegetation other than sage and some grass. It was wide open country with little protection from the sun and weather. Travel was dry and dusty. The important landmark of Independence Rock was reached by the vanguard company on June 21. William Sublette had named the rock, and it was widely known that this point should be reached by July 4 for safe passage to the West before the onset of winter weather conditions. Independence Rock is most famous for the names inscribed on its face, the names and dates of people who passed by this place in search of new life in the frontier. Climbing the 136 feet to the top of Independence Rock is rewarded by a fine view. Ten miles to the west are the rock hills of Devil's Gate and Martin's Cove. Devil's Gate is one of the most beautiful spots of the trail. It is formed by the river passing through granite rock, with walls as narrow as 50 feet and nearly 400 feet high. The beautiful Sweetwater River meanders through this area. The water is clear, refreshing, and indeed sweet to the taste. From this point the pioneers traveled west to cross the continental divide at South Pass. West of what is now Farson, Wyoming, the pioneers crossed the Green River. In this area, at the Little Sandy River, Brigham Young met with Jim Bridger. Although Mr Bridger had great knowledge of the Great Basin, the Mormons were skeptical of some of the information that he gave them. It was evident that Jim Bridger loved the valley of the Great Salt Lake, but he didn't encourage Brigham Young that the area would support a colony of people. Legend has it that

TABLE 1. Explorers and pioneers, definition according to Webster's New Twentieth Century Dictionary[3]

Explorers	Ones who travel for purposes of discovery in regions previously unknown or little known; synonyms: examine, pry into, hunt for, search, seed
Pioneers	Ones who go before into that which is unknown or untried to prepare the way for others, as an early settler or a scientist doing original work

TABLE 2. Pioneering principles: Methods to achieve success

- Identify need and establish purpose.
- Try to learn something new every day; be surrounded with people who stimulate learning.
- Do homework, building on known information; careful planning reduces risk.
- Build consensus.
- Follow established roads, but break new trails when necessary.
- Don't be discouraged by temporary setbacks.
- Make the project a lifetime work.
- Be prepared for scrutiny, shoulder criticism gracefully, and hope for relief.
- Keep the mind open to inspiration.

Mr Bridger offered $1000 for the first bushel of corn that could be grown in Salt Lake valley. Undeterred, the pioneers continued directly west to the Wasatch Mountains to follow the road cut 1 year previously by the Donner-Reed party past Big Mountain into Salt Lake valley. They found "Reed's Road," which the Donner party had taken nearly 3 weeks to construct down through Emigration Canyon, but did not follow it entirely into the valley. The Donner group apparently had become tired of chopping willows and trees, opting for a high road over a difficult, steep hill. The option may have cost them their lives by delaying crossing the summit in the Sierra range. The advance company of Mormons, led by Orson Pratt, however, made it over the Wasatch Mountains and through Emigration Canyon in 6 days and had a road made for those who would follow. What would they find at journey's end? What would be at the end of the trail when they entered the valley? When he saw the valley, Brigham Young declared, "This is the place, drive on." Thomas Bullock, clerk of the company, wrote the following[4]:

> *We succeeded in getting thro' the narrow spot of the Kanyon about 4 o'clock, when we turned round the hill and to the right & came in full view of the Salt Lake in the distance, with its bold hills on the Islands towering up in bold relief behind the Silvery Lake. A very extensive valley burst upon our view. . .about 30 miles long and 20 miles wide. The Sky is very clear, the air delightful & all together looks glorious. . . .Many kinds of grass appear, some being 10 or 12 feet high.*

Contrary to popular belief, the valley the Mormons entered in 1847 was no salt-caked, dusty, barren, desert wasteland. It was beautiful land, rich with fine grass and green vegetation. There was good fresh water in springs, creeks, and rivers. The mountaineers had loved the rich and fertile basin, and called it "Oasis of the Wasatch." The pioneers immediately began to plow the soil and plant potatoes and seeds. The soil was described as "fertile, friable loam, with fine gravel." It was a beautiful place, rather than a dry and dusty desert. It was a fine place to become home for a large population of people.

Pioneers who settled the West faced major challenges and considerable risk. Success of a pioneering effort appears to have been associated with some well-defined principles and methods (Table 2). Brigham Young had a need to provide security for his people. He learned everything he could about the West. He and his associates studied everything available regarding the various locations that would suit their needs. They were all in agreement. They followed the established Oregon trail, found Reed's Road, and only had to break trail for a short distance in Emigration Canyon. Brigham Young was not discouraged by the hardship of travel, illness, or occasional loss of life. He was optimistic about success, and he made the settlement of Salt Lake and other villages and cities in the West his lifetime priority. He was not without critics, however, and several writers of the day provided negative descriptions of him. He shouldered criticism gracefully and was not deterred in his vision. The vast majority of people who knew him admired and respected him. Brigham Young, his mind constantly open to inspiration, was the consummate pioneer, the great colonizer of the American West.

The 50 years after the entry of the vanguard company of pioneers to the valley of the Great Salt Lake saw great growth and many changes in their way of life. Those who endured the arduous overland travel to settle in the West found their answer to the American dream—a house which became their home and some land on which they could become self-reliant. For the Mormon pioneers, it was also relief from religious persecution. Crops flourished, and in the early 1850s there were abundant harvests. Optimism encouraged emigration. From 1849 to 1855, a total 16,000 emigrants were transported to Utah.

Travel over the Oregon-Mormon Trail eventually came to an end. Railroad construction reached further west every year. By 1858, emigrants could travel by train to the Missouri River, eliminating travel across Iowa. The transcontinental railroad finally stretched from coast to coast. This incredible engineering feat was accomplished by workforces the size of armies. The golden spike was driven at Promontory, Utah, on May 10, 1869, signifying the completion of the railroad. Up until that time, people could not travel faster than those who lived 2 centuries previously. On the railroad, they could travel at 60 miles per hour. Travelers could traverse the country quickly in relative comfort and safety. The days of long overland trips by wagon, camping along the way, were over. During these years some 70,000 people traveled the dusty long road to the Valley of the Great Salt Lake, and an estimated 300,000 emigrants traveled to Oregon and beyond. They have left a legacy of faith and courage that can only be quietly admired.

Salt Lake City grew and prospered. By 1900 the "Cross-

roads of the West" was a large and up-to-date city with many homes and some large buildings for business. The temple had been completed, and there was an electric streetcar on Main Street. During the next 50 years, the automobile entered and became part of life. The automobile became the symbol of the American success dream and a prominent force in the economy.[5] When I started to work for money ($0.25/h), my dream of financial success was earning $10,000 per year and owning a Buick with four portholes. The simple American dream was evolving to a home in the suburbs of a western city and one or more automobiles in the driveway. In addition, people began to live longer and fetal mortality dropped. Public health initiatives, such as clean water supplies, better heating of homes, better clothing, and better personal hygiene, were probably responsible for improved life expectancy. Medical care was gradually improving, but there were few effective tools. Medical practice generally, and cardiac surgery specifically, remained "on hold" pending important scientific discoveries. The discovery of the powerful anticoagulant heparin and its subsequent purification and the identification of its antagonist protamine were essential. Penicillin was discovered in 1928 but did not become available in quantities large enough for clinical use until the 1940s. Defibrillation of the human heart was accomplished by Beck in 1947 on the basis of earlier experimental work of Kouwenhoven. The possible role of hypothermia in cardiac surgery was suggested by Bigelow in 1950 on the basis of extensive laboratory studies. The important clinical events of the 1930s and 1940s included closure of patent ductus arteriosus by Gross in 1939, subclavian artery–pulmonary artery anastomosis by Blalock in 1944, and successful repair of coarctation of the aorta. It was Russell Brock who actually performed an operation on an intracardiac structure when he successfully dilated the pulmonary valve in 1948.

The American dream again evolved[5] to include an expectation of the American people for many things, including television, other products to make life easier, and improved health care with a longer active life. About 1950 cardiac surgery explorers, and subsequently the pioneers of cardiac surgery, entered to battle against cardiac disease, the greatest killer of Americans, to ensure the American dream of better health and longer active life.

Clarence Dennis had a working apparatus of a mechanical heart-lung machine by 1949. The oxygenator consisted of a set of revolving steel cylinders on which the blood would film to allow gas exchange. The machine was too large to get out the door of the laboratory, so it was redesigned to a series of rotating screens on which the blood filmed. This device was used in the first clinical open cardiac procedure on a human being in 1951.[6] Unfortunately, the patient died because the surgeons found complete atrioventricular canal defect rather than the simple atrial septal defect that they had expected. Their morphologic foundation was not sufficient to successfully correct the defect.

F. John Lewis[7] became the first surgeon to successfully close an atrial septal defect under direct vision. He applied principles suggested by Bigelow: lowering the body temperature, occluding the venous inflow to the right atrium, and, with the heart empty of blood, directly visualizing the defect in the atrial septum so that he could suture it. A large series of patients with 12% mortality followed the initial success.

John H. Gibbon, Jr,[7] is given the credit of being the first to successfully use mechanical cardiopulmonary bypass in a human patient. His experiments began in 1934. He was assisted by his wife. By 1947 he was performing successful complete heart-lung bypass and performing operations inside the hearts of experimental animals. By 1953 he was ready to apply this technology to human patients. The machine, built by IBM, consisted of a series of roller pumps to propel the blood (the heart) and vertical screens on which the blood would film and exchange gasses within an enclosed oxygen-rich chamber (the lung or the oxygenator). After an initial failure, success came in May 1953 with closure of atrial septal defect in an 18-year-old girl. Unfortunately, two subsequent patients died and Dr Gibbon placed a moratorium on further operations pending further study. He did not perform another open cardiac operation.

To this point I have been speaking of explorers of open cardiac surgery. They were the ones who pried into the realm of cardiac surgery with cardiopulmonary bypass but achieved only limited success. It remained for pioneers of cardiac surgery to apply the pioneering principles (Table 2) to achieve clinical success and make open cardiac surgery a clinical reality.

Identify Need, Homework, Learning, Follow Established Roads, Break New Trail, Consensus

The pioneer who would make open cardiac surgery with the pump-oxygenator a clinical reality was John W. Kirklin. He is a truly remarkable person. He is highly intelligent and analytical. He remembers everything and has all previous experiences cataloged in his brain, with an incredible recall ability. He is demanding and intense. He is technically refined and very precise. He likes having people around him that are intellectually stimulating and is continuously learning from great individuals in the disciplines of surgery, cardiology, radiology, pathology, statistics, and other sciences. He identified the need for open cardiac surgery while attempting to relieve right ventricular outflow tract obstruction by closed pulmonary valvotomy. There was subvalvular obstruction that thwarted his efforts. The patient died, and after study of the autopsy specimen from the case he correctly recognized that visualization of the internal structures of the heart was necessary for successful management of such cases. Kirklin and his associates from the Mayo

Clinic visited three institutions where pump-oxygenators had been developed but were not being used clinically.[8] They visited Gibbon and learned from him the design of his oxygenator, deciding that it could be adapted for successful clinical application. They followed the road established by Gibbon, returned to Rochester, Minnesota, and spent 2 years in collaboration with engineers at the Mayo Clinic reproducing as precisely as possible Gibbon IBM concepts in building the Mayo-Gibbon oxygenator, testing it in the research laboratory, and preparing for clinical application. Howard Burchell, Kirklin's cardiology associate, noted a strong interdependence (consensus) of medical, surgical, and laboratory disciplines at that time at the Mayo Clinic.[9] The team consisted of Kirklin in surgery, Burchell and Wood in cardiology, DuShane in pediatric cardiology, Swan in physiology, and Patrick in anesthesiology. A clinical experiment with the pump-oxygenator was carefully planned and rehearsed. A series of five patients would be operated on regardless of the outcome. They were selected from a group of patients who needed open operations for their otherwise ultimately fatal heart disease. Four of these five patients operated on in early 1955 survived, opening the modern era of open cardiac surgery with the pump-oxygenator. The clinical experiment was continued. Every case was considered a research case and was open to ethical and legal enquiry. Every complication was considered iatrogenic, not just a statistic. Difficult morphologic or pathologic features were challenges to be overcome, not to be blamed on the patient. Breaking new trail was required during this period, because operations never previously performed were necessary to correct the cardiac defects that were encountered. From this pioneering work has evolved greatly improved pump-oxygenators that have made cardiac surgery safe and reliable.

Discouragement, Life's Work

Where would cardiac transplantation be today had Norman Shumway become discouraged when Christiaan Barnard scooped the first temporarily successful cardiac transplant? Shumway and his residents had worked out the technique for cardiac transplantation in the early 1960s, while I was in medical school at Stanford. They were ready to go, but Barnard got there first. Was it because Shumway was too timid to proceed? I think not. I knew him as a bold yet careful cardiac surgeon. I admired his quiet, confident control in the operating room. My guess is that he wanted to be extra careful, performing sufficient experiments to ensure success. He entered the field of clinical cardiac transplantation when he was ready. It was his life's work. He succeeded when others gave up because of poor results. His group persisted, gaining steady, continuous clinical experience until cyclosporine (INN: ciclosporin) became available and cardiac transplantation evolved from an experimental procedure to an important clinical therapy for end-stage heart failure in many medical centers.

Scrutiny

Scrutiny accompanies any pioneering effort. A few years ago there was a powerful trend in cardiac surgery toward performing operations through small incisions, so-called minimally invasive surgery. The procedure was touted in such important forums as the *Today* show, the *Oprah* show, and the news media. Patients began to ask for minimally invasive operations. During a period that lasted about 2 years, I performed about 200 operations of all types through a lower half sternotomy. My clinical competence was scrutinized. There were three separate audits of the results of operations that I performed during this period, despite publication of the results in peer-reviewed journals. Fortunately, the three audits confirmed clinical competence and no added risk of the minimally invasive technique.

Criticism

Criticism stalks the pioneer. It comes from many sources, including hospital administration, nurses, pump technicians, anesthesiologists, and even our closest colleagues. The criticism may be vicious and damaging. William DeVries implanted the Jarvik 7-100 total artificial heart into Dr Barney Clark, a dentist with cardiomyopathy who was thought to be too old for cardiac transplantation. DeVries, handsome, young, and personable, instantly became a celebrity surgeon. He was the subject of numerous news features and appeared on the covers of magazines. Yet he was roundly criticized when Barney Clark died, with the harshest criticism coming from within his own institution. He sought relief and left Salt Lake City to pursue his clinical mechanical heart interests elsewhere. It took 10 years for the project to recover sufficiently in Salt Lake City to allow Doctors James Long, Don Olsen, and me to proceed with another implantation of the Jarvik 7-70 total artificial heart in a human being and to demonstrate clinical usefulness in a series of patients.

Scrutiny and criticism will accompany anything that is new. C. Walton Lillehei[10] noted the paradox between dedication to "new ideas" and opposition to their acceptance. Most new ideas have been surrounded by controversy and opposition before wide acceptance. Newness seems to offend the comfort zone and engenders complaint. Shouldering the load of scrutiny and criticism gracefully is difficult. It reminds me of the story of the mule in the well. The farmer heard the braying of his old mule. The mule had fallen into the well and was unable to get out. The farmer could not help him out of the well. After some thought on the predicament, the farmer decided that both the mule and the well were too old to be worth trying to save. He enlisted the help of his neighbors to fill the well with dirt and bury

the old mule to put him out of his misery. They began to throw dirt down the well by shovels. The old mule realized his plight and brayed loudly but the dirt kept coming down the well onto his back. Then it dawned on the mule that every time a shovel load of dirt landed on his back, he should shake it off and step up! This he did blow after blow. He fought panic and kept right on shaking it off and stepping up. It was not long before the old mule, battered and exhausted, stepped triumphantly over the wall of that well.

Inspiration

Gaining inspiration to choose the proper direction at forks in the road is an important and interesting process.

A man with a complex abnormality of the heart since birth (corrected transposition) was evaluated for cardiac transplantation. The heart had been worn down by the extra burden created by the abnormal structure of the heart. He had nearly reached the end of life, and the only hope was to replace the heart with one from another individual. In addition to the internal structural abnormalities of the heart, its position within the body was reversed (situs inversus). Heart transplantation had not been accomplished in such a patient. The problem was how to match the normal position of the heart to one in which everything was backward. I studied all the diagnostic materials available and became convinced that it could be accomplished. Several plans for the operation were considered. Drawings were created of how it could be done by rerouting blood flow inside the atria. The opinions of other surgeons were solicited. Despite all this preparation, there was a nagging feeling that our plan was not right. Several months passed. A donor was finally located, and the operation was scheduled. During the time required to obtain the heart from the donor in a distant town, I thought intently on the problem, reviewing all previous plans. Inspiration came. A completely new plan unfolded[11] in which we would reposition the superior and inferior venae cavae to the right side so that orthotopic transplantation of the heart in a normal anatomic relationship could be accomplished. The right atrium would be detached to create the passageway for the inferior vena cava to the right. The left atria and great arteries would be anastomosed as usual, and finally the cavae would be joined on the right side. The new plan of operation was accompanied by feelings of confidence that it would work. The operation turned out to be totally successful. The patient has done well for more than 10 years, and the venous passageways have remained patent and have functioned as a route for biopsy of the heart many times. New concepts of repair were revealed as a result of previous experience, careful planning as an interim step, and finally new insight into ultimate solution of the problem.

The process by which human intellect can visualize in advance what is to be created is indeed remarkable. From what source springs the remarkable process of inspiration and enlightenment? Most of the great creators of music and art attribute their source of inspiration to a source higher than their own human brain. Perhaps the crowning achievement of Michelangelo's creative life was the painting of the magnificent frescoes on the ceiling of the Sistine Chapel at the Vatican. Laboring from 1508 until 1512, Michelangelo performed this work himself without assistance. Meshberger[12] presented a thesis in the *Journal of the American Medical Association* in 1990 suggesting that Michelangelo encoded a special message in the fresco traditionally called the *Creation of Adam.* This fresco shows Adam and God reaching toward one another, arms outstretched, fingers almost touching. One can imagine the spark of life passing from God to Adam. But Adam is already alive, his eyes are open, he is alert, and he is completely formed. Isn't it more likely that what God is giving to Adam is intellect or inspiration, thus allowing him to plan the best and the highest and to try the things he has received? Meshberger's thesis is based on the idea that Michelangelo used a hidden image within the fresco. The outline of a midline section of the human brain is compared with the outline of the larger image encompassing God in the fresco. The two outlines are so remarkably similar that they can actually be superimposed, suggesting that the larger image encompassing God in the Michelangelo fresco is compatible with a brain and implying that a higher source gives to living man the inspiration for intellectual achievement.

Pioneering efforts by many cardiac surgeons provided great accomplishments during the period between 1955 and 2000. We might call this period the "Golden Era" of cardiac surgery. This period could be divided into decades to review what has been accomplished. The decade of the 1960s might be called the decade of discovery. Most congenital cardiac defects were treated. Valvular heart disease was treated with prosthetic valves or homografts. Coronary artery bypass and heart transplantation were accomplished.

The 1970s could be called the decade of analysis and expansion. Coronary artery bypass, mostly with saphenous vein grafts, became accepted, proven therapy for coronary artery disease. Cardiac surgery programs opened in many hospitals. Prosthetic valves were improved and became durable. Cardioplegia made operations safer and easier. The results of large series of patients were analyzed and reported in peer-reviewed journals. The role of the cardiologist in diagnosis and medical treatment was defined and quite separate from the role of the surgeon to treat by operation. These were the "good old days."

During the 1980s, the decade of perfection and evolution, things began to change. It became apparent that arterial grafts were preferred for coronary artery bypass. Cardiac transplantation flourished with the introduction of cyclosporine. Percutaneous transluminal coronary angioplasty was introduced, and cardiologists suddenly became "oper-

ators." The surgeon was often relegated to the role of standing around to provide a safety net for physicians performing procedures with complications that they were unable to treat. Although surgeons feared that coronary artery surgery would be lost, miraculously the case load did not drop, because cardiologists were content to treat patients with single-vessel disease that had previously been medically treated.

The 1990s were a decade of great progress. Improved bioprosthetic valves were introduced, and advanced mechanical circulatory assist devices became clinically useful, providing better bridges to transplantation and in some cases definitive therapy. Unfortunately, the specter of wider application of percutaneous catheter interventions, with their accompanying medical interventions, placed cardiologists and surgeons in competition. Hysteria and confusion gripped our practice. A multitude of procedures were introduced to try to hold on to operations by attempting to make them less invasive. Our lives became more difficult, more "managed," and the practice evolved to "provider business" with "marketing" and "market driven" becoming common terms of communication. Our forum became *The Wall Street Journal.*

So here we are, in Salt Lake City in the year 2002, well into the first decade of the third millennium. The city is now a modern cosmopolitan city that has grown in stature sufficient to have been the host for the Winter Olympics 2002. The future of the city looks bright. The American dream of long and active life surrounded by "things" that make our lives comfortable appears to have been realized. People are living longer, largely as a result of improved health care, in which we have been a major force. And what about cardiac surgery? What about our future? What will we make of it, keeping in mind that this decade will be characterized by what we do for ourselves? Shall we wallow in paranoia, self-pity, and depression over problems that are largely beyond our control? If so, this will be the decade of mass hysteria and confusion.

I was seated at a banquet table with Professor Sir Magdi Yacoub some months ago. Some young surgeons were seated with us, and one asked Sir Magdi, "How was it to be part of the 'Golden Era' of heart surgery now that it is, well, kind of over?" As is Sir Magdi's nature, he thought about the question carefully for some moments, and then answered: "The 'Golden Era' is *not* over, it is only *beginning.* Basic science and technology continue to flourish and will stimulate new methods of treatment. We just have to find them!"

This is the challenge for each of us: be a pioneer of our time and the future. It is not enough to study the accomplishments of the pioneers of cardiac surgery and to enjoy the benefits of their efforts. We have responsibilities that go along with the heritage. Being a clinical cardiovascular and thoracic surgeon is a big enough job for anyone. You may already be a pioneer in your own right. There are many among us who were the first in their families to complete a college education, then go on to medical school, and to climb to one of the highest peaks of specialty practice as thoracic surgeons. You could rest on your accomplishment and just hold on to what you have. But this is not enough, because we all know that satisfaction and protection of the status quo will evolve to decline and contraction. If your interests and abilities can be stimulated reach beyond performing operations and taking care of patients, you may become a pioneer. What is required is personal commitment, discipline, and resolve to do something more, the willingness to carry a briefcase home and do some work from it. There are many excuses, none of them valid. Find reasons to do something important and extra rather than finding excuses not to stretch for accomplishment.

It could easily be argued that we are not trained for basic or laboratory research. It is also not nearly as interesting as operating on patients. It is too difficult to organize a laboratory and acquire the funding. I agree. Research has become hopelessly regulated, to the point that invention is stifled. My hospital has a foundation for support of research with a large budget to give annually. Yet 35 copies of a well-written grant application are required to obtain seed money to do a pilot study of a good idea. Another lengthy application is required if experimental animals are required. Acquiring a large grant from a national funding agency is now nearly impossible for a clinical surgeon. If basic research is not within your reach, how about clinical research? This too has become highly regulated because of some serious problems with a few careless investigators. We need the help of trained clinical research nurses, and we need to become certified ourselves as understanding the rights of human subjects and informed consent. This, however, is not onerous and can be done in a relatively short time with the Internet. Joining a clinical trial is then possible. There are plenty of them available, and willingness to participate is one of the main factors in being part of the trial. The operating room and the hospital become the laboratory.

Okay, research is not for everyone. How about teaching? There are plenty of opportunities for teaching. Health professionals at all levels want to learn. Developing content to give to an audience is the challenge. The rewards, however, are enormous. There was a time when our residents in training were not performing well on their American Board of Thoracic Surgery qualifying examinations. We were not proud of a 50% failure rate. The need to prepare them better was obvious. I did some homework and some planning, outlining a list of subjects that were essential to the basic knowledge of a thoracic surgeon. We learned something of review courses that were offered in various medical disciplines. To this point we followed established roads, but then

inspiration guided the breaking of new trail. An inspired idea emerged for a review course consisting of 75 topics presented in concise 20-minute presentations preceded and followed by pertinent test questions. The content or the core curriculum was developed by having readers extract key materials from the important textbooks. This material was assigned to our teaching faculty for development of the presentations. All agreed to participate so that there was consensus and ownership. The course was presented to a small audience the first year but grew rapidly, and now the course is oversubscribed. Enhancements have been made every year, and the lectures are updated annually. All our residents pass their examinations now, and many other young surgeons seem to have benefited. The course is presented on an 18-month revolving cycle on the CTSNet Resident's section. It has become the basis for didactic resident training in some residency programs. The course is now self-contained in electronic format and has been presented at international sites. All we need is an electric power plug to run the laptop computer and slide projector and an interested audience. The benefits to the teaching faculty have been the good feelings from service rendered (no honoraria are given) and professional collegiality that extends far beyond the course.

Regarding international teaching, there are many opportunities to provide humanitarian service in developing countries. I have had the privilege of teaching and operating in the People's Republic of China on many occasions during a 19-year period. I have seen cardiac surgical care progress from primitive to highly advanced in some centers as China has emerged from a backward third-world country to a modern, high-powered world economic force. When I went to China in 1983, coronary artery bypass was virtually unknown. Now it is routine in many heart centers, with a high proportion of the operations performed off pump. Cardiac operations performed for infants in 1987 required only demonstration of the basics of closure of ventricular septal defect in patients younger than 2 years. Two years later, more than 200 patients had undergone that operation, which by then was routine. All one needs is the willingness to take some time from practice. You will be missed only temporarily, and your work will be waiting for you to return. Give of your talents without expectation of compensation other than the blessings and feelings that one always receives from giving. The most meaningful work that you will do during your professional career will usually be that which you do without pay.

Tracing our roots to ancestors who courageously came to the West as emigrants under difficult circumstances of overland wagon travel or even on foot can bring great family and personal pride and gratitude. Some of us who live in the West have such ancestors. There are many more, however, who do not. Their families may have come to the West only recently, emigrants and pioneers, nevertheless. Their circumstances, although different from those of the pioneers of the 1800s, were no less difficult. Perhaps these recent pioneers do not have roots in the West that run as deep as some others, but their efforts will make a better place for all who follow. It is a peculiarly western American notion that people are measured by how tall they stand in their boots, not by where the boots came from or how much they cost.

I have tried to draw a distinction between an explorer and a pioneer. Explorers enter a region or field of endeavor for the purpose of discovery, whereas pioneers are those who go before to prepare the way for others. I repeat my challenge to evolve from an explorer, dabbling at the edges and only taking what we can gain from thoracic surgery, to be a pioneer and get the pioneering spirit into our professional lives. Ours is the greatest specialty in medicine. We have a large number of operations to use in treatment of a large variety of maladies. We have advanced and precise diagnostic methods that allow us to know before operation what we will encounter. We can see the pathologic status with our own eyes and have the basis on which to interpret what we observe. We know the outcomes of our operations, because our specialty is more tightly monitored and measured than any other. Stretch your effort to do something important that will raise the wonderful medical specialty of thoracic surgery out of the doldrums of paranoia. If you will do this, I promise that you will find equanimity in a time of torment and will prepare the way for those who follow us into the practice of thoracic surgery, that they may find the same joy in the work that we have experienced both in the past and at present.

References

1. Hawking SW. The universe in a nutshell. New York: Bantam Books; 2001.
2. Schmidt T, Schmidt J. The saga of Lewis & Clark into the uncharted west. New York: DK Publishing; 1999.
3. Webster's new twentieth century dictionary of the English language. 2nd ed. New York: HarperCollins; 1979.
4. Bagley W, editor. The pioneer camp of the saints: 1846-1847. Mormon trail journals of Thomas Bullock. Spokane (WA): Arthur H Clark; 1997.
5. Allen TB, editor. We Americans. Washington, DC: National Geographic Society; 1975.
6. Nelson RM. Era of extracorporeal respiration. *Surgery.* 1975;78:685-93.
7. Westaby S. Landmarks in cardiac surgery. Oxford: Isis Medical Media; 1997.
8. Kirklin JW. Open-heart surgery at the Mayo Clinic: the 25th anniversary. *Mayo Clinic Proc.* 1980;55:339-41.
9. Burchell HB. Contributions of the basic sciences to successful clinical application of cardiopulmonary bypass. *Mayo Clin Proc.* 1980;55: 754-7.
10. Lillehei CW. New ideas and their acceptance. *J Heart Valve Dis.* 1995;4 Suppl 2:S106-14.
11. Doty DB, Renlund DG, Caputo GR, Burton NA, Jones KW. Cardiac transplantation in situs inversus. *J Thorac Cardiovasc Surg.* 1990;99: 493-9.
12. Meshberger FL. An interpretation of Michelangelo's Creation of Adam based on neuroanatomy. JAMA 1990;264:1837-41.